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DEVELOPMENT OF THE DELAWARE RIVER FOR COMMERCE

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WATERWAYS DIVISION

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DEVELOPMENT OF THE DELAWARE RIVER FOR COMMERCE

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The waterways of our country have provided a principal means of conducting commerce from the beginning of our history. Indeed, the need for central control of commerce among the colonies was an important factor leading to the calling of the Constitutional Convention. When the Constitution was established, an express power was delegated to the Congress "To regulate Commerce with foreign Nations, and among the several States, and with the Indian Tribes."

The Federal program for improving the Nation's rivers and harbors for navigation is now in its 130th year. It embraces 2,279 authorizations that range in scope from minor streams kept open for limited navigation by periodic removal of snags and other obstructions, to major projects for improving the principal rivers and harbors of the nation. The program provides for improvement and maintenance by the Corps of Engineers of 417 coastal and lake harbors, excluding small fishing harbors, and ranges from minor ports to the greatest harbors in the world. The commerce and industry that depends upon our major waterways is a national asset of critical and growing importance.

The project depths in the channels in United States seaports have been developed over the years as recommended by the Chief of Engineers, U. S. Army under Congressional authorization in accordance with the needs of navigation. The basic requirement for a favorable recommendation is that the annual benefits reasonably to be expected from an improvement, evaluated on a monetary basis, be at least equal to the estimated annual cost of the work including interest on and amortization of the investment, and the operation and maintenance costs. The principal sources of monetary benefits considered are: (a) savings in cost of transportation service, (b) the provision of service at a cost which will attract new traffic and (c) the reduction in damages to ships and structures related to navigation. In recent years, the military security of this country has become an increasingly important factor in this work.

These navigation improvements carry a huge tonnage of valuable foreign and interstate commerce. The availability and use of water transportation has lowered prices by keeping the overall transportation cost of the Nation low. This has substantially benefited all of the people, whether they live, work, or operated businesses on navigable waters or in the interior. Navigation improvements have returned

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benefits to the Nation far in excess of their cost.

The objective in selecting channel dimensions is to provide a safe and efficient waterway for the size and number of vessels expected to use the facility within the reasonably foreseeable future. If the channels are to meet these capacity requirements with a degree of safety and efficiency of transit, they should be adequate to permit the largest commercial vessels in frequent transit, or proposed for frequent use, to operate without undue hazard or delay under conditions of weather, vessel traffic, tidal phenomena, and other conditions affecting navigation normal to a particular facility.

Historically, increasing capacity and draft of vessels have preceded the related artificial increase in depths of seaports. This process has resulted in disadvantages to shipping arising from: (a) sailings with less than capacity cargoes, (b) partial lightening of full cargoes to reduce draft, (c) loss of time waiting for high tide and (d) damages to vessels because of inadequate clearances. In this same connection, it is desired to note that in many instances the development of ship design has proceeded so rapidly that navigation improvements have become obsolete shortly after their completion.

This experience throughout the long history of navigation improvement suggests there may be merit in giving more consideration to providing such improvements in advance of the immediate need. It seems that such improvements, soundly conceived, would have a powerful influence in accelerating the development of larger and more efficient ships and in stimulating the growth of tributary commerce and industry. This concept has, to some extent, entered into the formulation of the project for deepening the Delaware River above Philadelphia.

The Delaware River (see Fig. 1), with the main stream and its tidal tributaries reaching far inland from the sea, gained early recognition from the settlers of the newly discovered continent as affording excellent economic opportunities. The landlocked harbor sites protected from ocean storms were important to the pioneers who depended upon frail wooden vessels as a means of transport. It did not take long for Philadelphia to be established as an important port in the new world. For a time, it was the major port, and it is still the second largest in the Nation.

Federal participation in the development of navigation improvements on the Delaware River originated in 1802 with appropriation of funds for pier construction at Philadelphia. That work was accomplished by the Corps of Engineers. Since 1836, Congress has authorized 34 projects for improvement of the River and its tributaries in the interest of navigation, which vary in scope and importance from minor improvements accomplished at small expenditure to major projects costing millions of dollars. Twenty-four of these projects are still in use today, and are decided economic assets to the tributary areas they serve and, in a broader sense, to the Nation as a whole. Modification of many of these projects has been necessary from time to time during the years to keep pace with the expanding demands of navigation and the vigorous and expanding industrial development which has characterized the area.

Facilities for the accommodation of navigation on the Delaware are extensive. The railroads serving Philadelphia provide connections to all piers handling cargo vessels and permit loading and discharge direct from cars. The marine terminals at Wilmington, Camden, and Trenton have equally satisfactory rail connections. Car-float and lighterage facilities are also available. Along both banks of the Delaware, Christina and Schuylkill Rivers, there are over 400 piers, wharves and ferry slips of which 200 are at Philadelphia, 82 at Camden, 38 at Wilmington and 85 at other points along the River. Extensive facilities are available for the handling of lumber, grain, coal and other bulk commodities. The petroleum industry is heavily concentrated along the Delaware River. It is one of the largest oil refining centers in the United States and in the world. There are six main refineries in the area, in addition to numerous other petroleum terminals. Shipbuilding is one of the principal industries along the Delaware and facilities for docking and repair of large ocean ships are available. At the Philadelphia Naval Base are three graving docks, the largest of which can accommodate vessels up to 1,000 feet in length and 110 feet in beam. The New York Shipbuilding Company at Camden is one of the largest shipbuilding yards in the United States and has constructed many war ships, passenger liners, tankers and freighters. At Chester, about 13 miles below Philadelphia, the Sun Shipbuilding and Drydock Company has ways for constructing large vessels as well as a completely equipped marine repair plant.

An important segment of the Nation's steel productive capacity is located along the Delaware River. Steel plants at Trenton, Philadelphia and Claymont, Delaware, have an annual capacity in excess of 1,100,000 tons. The new U. S. Steel plant at Morrisville, Pa. has a capacity of 1,800,000 tons annually. In addition, there is soon to be constructed another new steel plant by the National Steel Company at Paulsboro, N. J.

Industries using water-borne raw materials, both imported and domestic, as well as industries which export finished products, account for the tremendous tonnage of commerce which moves on the Delaware River. Commerce in the Delaware River between Philadelphia and the Sea expanded from 23 million tons in 1928 to 55-1/2 million tons in 1952, an increase of 142 percent. In each of the two war years 1943 and 1944, the combined money value of foreign exports and imports was well in excess of a billion dollars. The commerce on the Delaware River between Philadelphia and Trenton has grown from 5 million tons in 1928 to 7 million tons in 1952, an increase of 40 percent.

In 1952, vessels with drafts up to 40 feet made 192,172 trips on the river below Allegheny Avenue, the upper end of the Philadelphia to the Sea project, and vessels with drafts up to 30 feet, but drawing mainly 9 feet made 18,261 trips on the section from Philadelphia to Trenton.

It is interesting to note that the traffic drops off abruptly in the vicinity of Allegheny Avenue where the channel changes from 37 feet deep below Allegheny Avenue to 28 feet above. Similarly the area along the river above Allegheny Avenue changes from one of intensive industrial development to one of open areas and residential sections with industry dispersed at points in between.

The improved navigable channel in the Delaware River extends 129 miles from the sea to Trenton, N. J. Generally, the project depth is 40 feet from the sea to the Philadelphia Navy Yard. From the Navy Yard to Allegheny Avenue, Philadelphia, which is the reach of greatest concentration of docks and shipping facilities, a 37-foot channel is authorized. Above this point the project depth is 28 feet to the Pennsylvania Railroad Bridge at Delair, thence 25 feet to the marine terminal in Trenton. A 12-foot channel is also provided between the marine terminal and the Pennsylvania Railroad bridge at Trenton.

The total cost of these projects to 30 June 1953 was $33,650,000 for construction and $67,623,000 for maintenance. Customs collections alone have exceeded the total costs of the projects many times over.

With the construction of the U. S. Steel plant at Morrisville, Pa., the Delaware River has become an important carrier of iron ore and finished steel products. Recognizing the possible need for the improvement of this waterway, the Congress, through resolutions adopted by the Committees on Public Works of the Senate and the House of Representatives requested the Board of Engineers for Rivers and Harbors to determine if any modifications of the existing projects were feasible.

Private industry has already invested its resources in an unprecedented industrial expansion in the region and there is substantial evidence that the expansion is only in its initial stages. In the course of the investigation, existing and prospective private industries in the area were open and frank in the disclosure of confidential future plans to a degree unequaled on any other project with which the author has been associated. Such information was furnished in writing over the signatures of responsible heads of large industries.

As an example of the reality of the need for improvement, it is anticipated that within the next few months ore carriers 700 feet long with beams of 100 feet and loaded draft of 35 feet will be operating on the river up to Morrisville. Under present channel conditions, these ships will be limited to a load-draft of 23 feet. Also, tankers having comparable dimensions are now in existence and are potential users of a deep waterway to Trenton.

The improvements considered above Philadelphia would add some 60 miles of deepwater harbor frontage which in itself would be a large increase in low cost transportation facility tending to encourage and accelerate the industrial development of the area.

As a result of the investigation, it was concluded that the National Defense, the growing demand for defense and civilian goods, the strategic location of the Trenton-Philadelphia-Camden area with respect to sources of material and labor and markets for processed goods together with the definite possibility of increasing the National wealth justified the further improvement of the waterway.

The Chief of Engineers has submitted a report to Congress for consideration which recommends in effect that the present 40-foot channel ending at Philadelphia be extended upstream to Newbold Island (Morrisville) with a depth of 42 feet in rock and 40 feet in other material and a width of 400 feet; thence upstream to Trenton with a depth of 35 feet and a width of 300 feet. Two major bridge crossings in the reach were also considered. The Delair bridge, a railroad crossing, was found to

require reconstruction as part of the project to provide adequate navigation clearance. The Tacony-Palmyra bridge, a highway bridge, was not included for reconstruction as part of the project on the basis that it is adequate for the navigation needs of present commerce. As a separate matter however, it should be noted that the major traffic jams caused by its opening during rush hours are causing considerable concern and together with increasing navigation may eventually justify its reconstruction. The total cost of the improvement is estimated at $92,385,000. The resulting benefits estimated conservatively are expected to exceed the cost by a ratio of 1.93.

Some of the engineering aspects of the proposed plan of improvement are as follows:

The ore vessels for which adequate channel capacity is desired will have a loaded draft of 35 feet in salt water, and are about 700 feet long and about 100 feet in beam width. The minimum channel depth that would suffice for these vessels in the fresh water in the Delaware was found to be 40 feet. Channel widths of 400 feet from Philadelphia to Newbold Island and 300 feet from Newbold Island to Trenton were selected on the basis of engineering judgment after consideration of the types of vessels expected to use the channel, the physical and economic aspects of the project area, and in the light of Corps experience on other waterways throughout the Nation. It is believed the recommended depths and widths would prove entirely adequate for all commerce prospective in the foreseeable future.

The improvement would involve the removal of 2,393,000 cubic yards of rock and 42,040,000 cubic yards of other material, and the removal of scattered boulders. The estimate of the quantity of material to be removed was computed from shore-to-shore soundings taken on lines approximately 400 feet apart. The estimate of the quantity of rock to be removed was computed from data obtained from drive and jet probings to rock on lines generally 1,000 feet apart and from 20 core borings that were spaced between Torresdale and Newbold Island. The estimate of yardages of material other than rock to be dredged was based on channel side slopes of 1 on 3. The estimate of yardages of rock to be removed was based on channel side slopes of 1 on 1. Both estimates include allowances for 2 feet of overdepth dredging.

As previously stated, the proposed depths in the rock sections of the 40-foot reach are 42 feet. The character of the bottom is important from a maintenance standpoint. Maintenance dredging in rock channels is more costly if the actual depth to rock is the same as the authorized channel depth. Experience in maintaining channels in rock which are subject to shoaling has demonstrated the desirability and economy of providing a minimum depth of 2 feet below the authorized depth to facilitate maintenance.

The general allowance of 2 feet of overdepth dredging in all reaches overcomes inaccuracies in the dredging process and insures that the full channel depth would be obtained at least cost.

In the reach between the Philadelphia Naval Base and Allegheny

Avenue, dredging of material other than rock would be accomplished by the use of a hopper dredge discharging into a rehandling basin with spoil transferred therefrom to disposal areas by pipeline dredge. There are no suitable disposal areas available for use by pipeline dredges working directly in the channel. In the reach between Allegheny Avenue and the Trenton Marine Terminal, dredging of material other than rock would be accomplished by 27-inch pipeline dredges pumping directly into shore disposal areas, which under terms of the project, would be provided by local interests.

Rock excavation would be accomplished by the use of drill boats and dipper dredges. Disposal of the excavated rock would be accomplished by placing about 50 percent of the quantity in an inshore area of the river between Mantua and Woodbury Creeks, and by dumping the remaining 50 percent in deep holes in Delaware Bay in the vicinity of Brandywine Light.

To accommodate the large vessels for which the channel is planned, it would be necessary to provide a wider navigation opening in the Delair bridge of the Pennsylvania Railroad which now has a horizontal clearance of only 122 feet. The tidal currents at this bridge are strong and oblique to the axis of the bridge. Strong winds occur frequently and add to the difficulty of passing through the bridge draw. Moreover, the change in channel alignment that would accompany the enlargement of the channel for use by large vessels would require that the navigation opening of the bridge be located to the west of the existing opening. The reconstruction of the bridge would involve construction of a new lift span and piers, and other work necessary to provide a navigation opening of 500 feet. The bases of the new piers would be at elevation—50 and carried on steel piles driven to rock. Studies made of the existing bridge indicated that it could be rated as an E-45 structure and the estimates of cost of reconstruction are based on design for that loading.

On the assumption that funds would be made available as required, it is estimated that the work involved in providing the 40-foot and 35-foot channels from Allegheny Avenue, Philadelphia, to the Trenton Marine Terminal can be accomplished in a 4-year period.

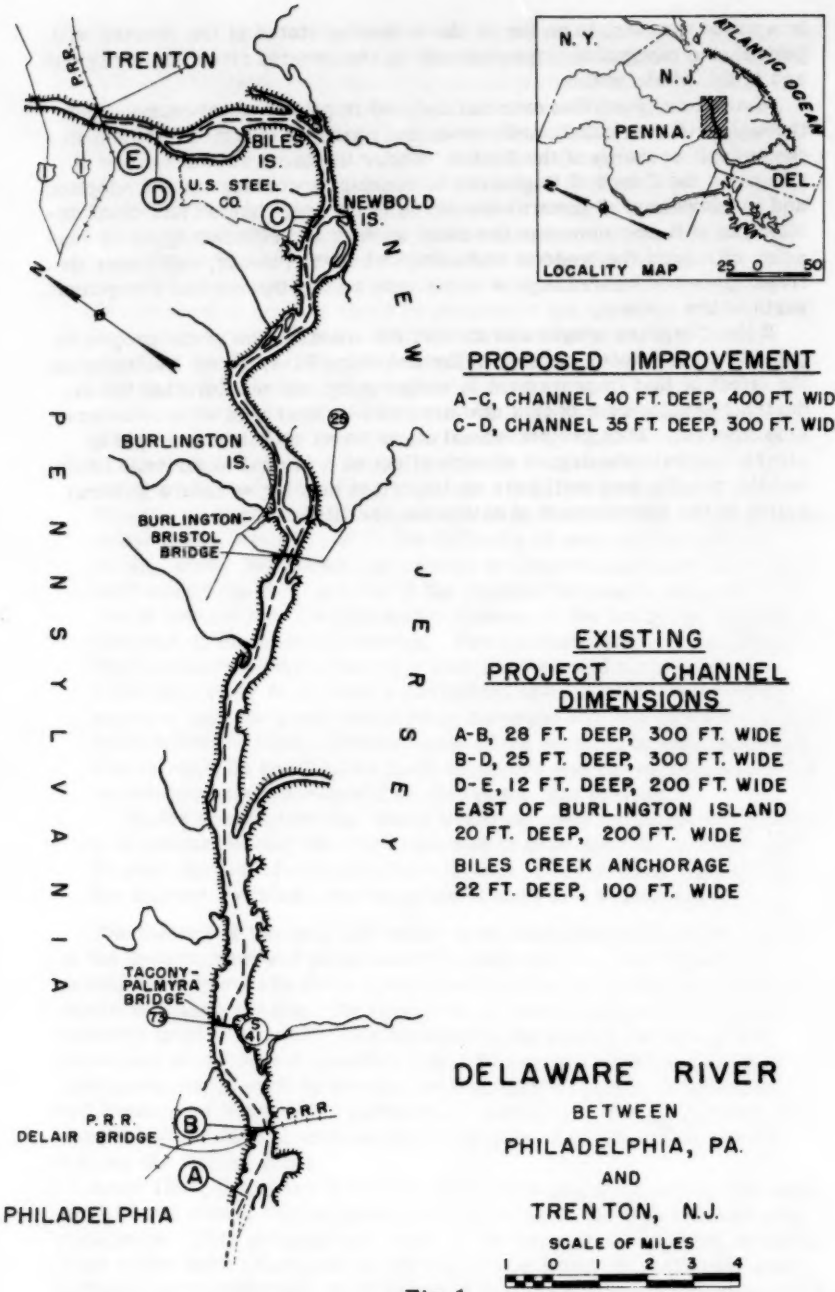
The history of the past 100 years is to a considerable extent a story of the development and progress of transportation. Our industrial growth largely results from and depends on the progress and developments in transportation. To remain in a healthy competitive position, industry must continually look forward to the steady receipt of raw materials at the lowest possible cost. Highspeed and high-cost land transportation is used by people and high-priced goods; lower speed and lower cost water transportation is essential to the large basic industries which have prospered and have played an important part in making the Nation great.

Since 1824, Congress has fostered a sound and progressive development of our rivers and harbors in the interest of foreign and domestic commerce. This program has been in the interest of optimum development of the several regions of the country in terms of their own potentialities and limitations. It is believed that the Congress has integrated

in a sound manner, in so far as the economic status of the country will permit, the navigation improvements in the several river basin regions and in the whole Nation.

Water transportation over natural and improved watercourses and through artificial canals and connecting channels is a vital element in the overall economy of the Nation. Under the many authorizations of Congress the Corps of Engineers is constantly working toward adoption and improvement of general standards of harbor, channel and canal design that will accommodate the most modern and efficient types of vessels, anticipate the trend in technological developments, and foster the freest possible interchange of commerce among the various component parts of the system.

If the Congress adopts and directs the construction of the project to provide a deep water channel in the Delaware River above Philadelphia, the effect of that improvement in encouraging and accelerating the industrial development of this new area will be observed with considerable interest. This project should serve as an excellent example to clearly indicate the degree of such effect on a factual experience basis and the results may well have an important bearing on future Federal policy in the development of navigation facilities.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LOCALITY MAP
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PROPOSED IMPROVEMENT
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C-D, CHANNEL 35 FT. DEEP, 300 FT. WIDE
EXISTING
PROJECT CHANNEL
DIMENSIONS
A-B, 28 FT. DEEP, 300 FT. WIDE
B-D, 25 FT. DEEP, 300 FT. WIDE
D-E, 12 FT. DEEP, 200 FT. WIDE
EAST OF BURLINGTON ISLAND
20 FT. DEEP, 200 FT. WIDE
BILES CREEK ANCHORAGE
22 FT. DEEP, 100 FT. WIDE
DELAWARE RIVER
BETWEEN
PHILADELPHIA, PA.
AND
TRENTON, N.J.
SCALE OF MILES
1 0 1 2 3 4

Fig. 1

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The technical papers published in the past year are presented below. Technical-division sponsorship is indicated by an abbreviation at the end of each Separate Number, the symbols referring to: Air Transport (AT), City Planning (CP), Construction (CO), Engineering Mechanics (EM), Highway (HW), Hydraulics (HY), Irrigation and Drainage (IR), Power (PO), Sanitary Engineering (SA), Soil Mechanics and Foundations (SM), Structural (ST), Surveying and Mapping (SU), and Waterways (WW) divisions. For titles and order coupons, refer to the appropriate issue of "Civil Engineering" or write for a cumulative price list.

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a. Presented at the New York (N.Y.) Convention of the Society in October, 1953.
b. Beginning with "Proceedings-Separate No. 290," published in October, 1953, an automatic distribution of papers was inaugurated, as outlined in "Civil Engineering," June, 1953, page 66.
c. Discussion of several papers, grouped by Divisions.
d. Presented at the Atlanta (Ga.) Convention of the Society in February, 1954.
e. Presented at the Atlantic City (N.J.) Convention in June, 1954.

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